# High-intensity laser therapy on hamstring muscle length among young adults

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SYNOPSIS SUBMITTED

To

**Maharishi Markandeshwar (Deemed to be University)**

Mullana, Haryana, India

In partial fulfillment of the requirements for the degree

**Doctor of Philosophy**

**(Physiotherapy)**

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**SUBMITTED**

**By**

**Adarsh Kumar Srivastav**

Roll No: 1820741

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**Supervisor**

Dr. Asir John Samuel, PhD (Physiotherapy),

Associate Professor, MMIPR, MM (DU), Mullana-Ambala

MAHARISHI MARKANDESHWAR INSTITUTE OF PHYSIOTHERAPY AND REHABILITATION

MAHARISHI MARKANDESHWAR (DEEMED TO BE UNIVERSITY)

(Accredited by NAAC with Grade "A")

MULLANA-AMBALA, HARYANA

# Certificate

This is to certify that the PhD thesis synopsis / protocol on, **"High-intensity laser therapy on hamstring muscle length among young adults"** has been done by Adarsh Kumar Srivastav under my supervision. I am satisfied with the work presented by the candidate towards the partial fulfillment of Doctor of Philosophy (PhD) in Physiotherapy. This is an original work submitted only to Maharishi Markandeshwar (Deemed to be University), Mullana-Ambala, Haryana, and is free of any plagiarism at the time of his submission.

24.09.2021

24.09.2021

PRINCIPAL
MM Instt of Physiotherapy & Rehabilitation
Maharishi Markandeshwar (Deemed to be University)
Mullana-Ambala-133203

**Supervisor**

**Dr. Asir John Samuel, PhD (Physiotherapy),**
Associate Professor,
MMIPR,MM (DU),
Mullana-Ambala, Haryana.

Dr. Asir John Samuel,
PhD (Physiotherapy),
MPT (Neuro & Pediatric Neuro),
BPT, MIAP (L-27452), BSc, DYScEd
Assoc. Prof. MMIPR, MM (DU)

**Date:** 29-09-2021

## List of Abbreviations

**AKET:** Active knee extension test

**ATP:** Adenosine triphosphate

**BMI:** Body mass index

**HILT:** High-intensity laser therapy

**HML:** Hamstring muscle length

**HPLT:** high-power laser therapy

**MSRT:** Modified sitting reach test

**LLLT:** low-level laser therapy

**LASERS:** Light Amplification by Stimulated Emission of Radiation

**MVC:** Maximal voluntary contractions

**OPD:** Outpatient department

**PSLR:** Passive straight leg raise

**RM:** Repetition maximum

**ROS:** Reactive oxygen species

**ROM:** Range of motion

**SRT:** Sitting Reach Test

**SPSS:** Statistical package for social science

**TG:**Training group

**TLG:** Training and laser group

**VAS:** Visual analogue scale

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## Abstract

**Background:** Prolonged sitting and sedentary life style may results in hamstring shortness. Decline in regular physical activity could lead to decrease in flexibility and strength of muscle in younger adult population. Increasing hamstring muscle flexibility could decrease the possibilities of injuries and prevent low back pain. Application of high-intensity laser therapy has proved to be innumerable benefits to the many conditions. However, until date no published research is available on the effectiveness of high-intensity laser therapy (HILT) to improve hamstring muscle length in healthy young adults.

**Purpose:** To establish the benefits of HILT in treating hamstring muscle tightness among young adults.

**Methods:** A total of 154 healthy young individuals will be recruiting by purposive sampling method to participate in a randomized, single-blinded, sham-controlled study. Recruited participants will be randomly dividing into two groups, the Active HILT group and Sham HILT group. The treatment duration will be 10 minutes per session on both lower limbs for each day for 3 days/week for 2 weeks. The active knee extension test, and sit and toe touch test are the outcome measures will be recorded at baseline, end of the 2-week post-intervention period.

**Discussion:** This study will provide data to determine HILT would be a future definitive nonpharmacological, non-invasive option for young adults.



**Keywords:** Flexibility; Hamstring; Laser therapy; Young adults.

# Chapter 1: Introduction

Muscle tightness is produced by a reduction in the muscle's capacity to deform, resulting in a reduction in the joint's range of motion. Hamstring tightness, which is commonly defined as a loss of range of motion combined with a feeling of limitation in the posterior thigh, has been linked to functional or impaired hip movement in people of all ages.[1] Postural abnormalities and muscle tightness have been connected and play a role in a variety of musculoskeletal issues.[2] Reduced hamstring flexibility as a result of increased hamstring stiffness may contribute in low back problems. Hamstring tension has been linked to changes in sagittal spine curvatures during trunk flexion, according to clinical observations. Hamstring tightness is defined as the inability to extend the knee beyond 160 degrees with the hip in 90 degrees of flexion.[3] Athletes who participate in contact sports have much greater rates of hamstring tightness than athletes who participate in athletics, martial arts, and other sports (swimming, weight lifting, volley ball, baseball, hockey, cricket, and tennis), respectively.[4] Optimizing hamstring and low back flexibility can help you avoid musculoskeletal injuries, low back difficulties, postural deviations, gait limitations, and falling. Various factors such as, patellofemoral joint dysfunction, pubic pain, low back pain (LBP), and postural abnormalities influence the length of the hamstring muscles. Tight Hamstrings in elderly persons can cause problems with dynamic balance by reducing stride length and walking speed.[5]

Hamstring tightness is associated with the pelvic movement and posterior pelvic tilt, which lead to decrease in lumbar lardosis and cause mechanical back pain. 96% of female and 4% of male reported overall hamstring tightness among college going adult population. In 2010, Shanka Weerasekara et al conducted a study on the prevalence of hamstring tightness among male athletes at the University of Peradeniya. The frequency of hamstring tension was considerably greater among athletes who participated in contact sports compared to the other sports studied. No significant relationship between hamstring tightness and body height, femoral length, or the length of warm-up and cool-down periods, reported in their study. As a result, athletes who participate in contact sports should take special precautions to avoid hamstring strain.[4]

A study reported the prevalence of hamstring tightness among college students by examining the relationship between right and left hamstring length in both genders. Tightness of hamstring muscle were present in all the participants. The study's findings show that there was a significant correlation between the right and left hamstring muscles in both groups, but no correlation between hamstring length when comparing right hamstring length to left hamstring length. In comparison to female subjects, male subjects had more tightness in the left and female subjects had more tightness in the right. Female subjects had a higher linear prevalence of hamstring tightness than male subjects.[5]

Hamstring tightness has an impact on posture, gait, and how the body moves during activity. It occurs when a tissue is immobilized in a shorter posture, resulting in diminished elasticity of normal tissue, a shift in the muscle's length tension relationship, and a decrease of flexibility. Hamstring tightness is caused by a combination of variables including flexibility, weakness, and lack of neuromuscular control. Muscle stretching frequency and duration may hinder with flexibility progress. Biomechanical, neurological, and biochemical alterations all contribute to the decreased flexibility. Any hamstring problem will be exacerbated by a lack of flexibility in the hamstring muscles, which can also be the origin of the problem. The tight hamstring muscles cause the hip to tilt backwards when the leg is extended. Tighten hamstrings drag the pelvis and hips out of line, affecting posture and flattening the back, which loses some of its natural curve. Because of the length tension relationship with the quadriceps, the knee joint can become imbalanced and more likely to develop osteoarthritis if the hamstrings become uniformly tight. Loss of hamstring flexibility can cause lumbar lordosis to decrease, muscular strength to decrease, and quadriceps dysfunction during walking.

Due to sedentary lifestyle and reduced physical activity and lower energy expenditure leads to lower basal metabolic rate. Due to reduced physical activities, the rate of muscle loss will be accelerated. Maintaining physical activity is one of the techniques to combat muscle loss.[6,7] Decreased muscle strength in individuals with sedentary lifestyles can be associated with

muscle atrophy due to increasing age and inadequate activity, resulting in a loss of muscle mass and strength.[8]

Tightness of hamstring is very common problems in students especially having prolonged sitting hours. 82% of students reported hamstring tightness when assessed with straight leg raise test.[9] Increased sitting activities or reduced physical activities could lead muscle tightness, decrease strength, power and functional capacity. Sedentary activity for longer duration causes a decrease in protein synthesis and accelerates the loss of muscular mass, strength, power, and functional capacity in individuals. Pre-existing sarcopenia exacerbates the unfavorable metabolic and morphologic effects of sedentary activities.[7]

Reduced hamstring muscles flexibility due to prolonged slumped sitting position and increased flexion at the spinal level results into low back pain and significant damage to muscles properties. The chronicity of back pain was found to be substantially linked to muscular endurance and power.[10] Researchers reported that Hamstring muscle tightness can be corrected with various therapeutic approaches and conservative treatments, including traditional stretching exercise, various thermal and non-thermal modalities such as, hydrocollator pack, cold pack and low level laser therapy on muscle tightness.[11–13]

Muscle stretching does not promote muscular length on its own; however, high-force stretching can cause muscle tissue damage. According to a published systematic review, it is

suggested that stretching does not lessen the risk of injury.[14] Literatures shows stretching is not effective in reducing the occurrence of injury and increase in hamstring muscle length. A single 90-second hold stretching of the hamstring muscles resulted in a 30% reduction in viscoelasticity; however, this effect only lasts one hour after stretching is completed.[15] Cold and hot packs have shown to affect the contractile properties of muscles. The maximum voluntary contraction value decreased with cold water immersion, and the passive torque at a given ankle joint angle decreased with hot water immersion. In a study, it has been reported that during isometric contraction of the gastrocnemius muscle, the connection between estimated muscle force and elongation of each structure (tendon–aponeurosis complex, tendon) remained unchanged in both hot and cold immersions.[16] Clinical trials have shown the benefits of low level laser therapy modality in the treatment of muscles injuries.[14,17–21]

Light has a biomodulatory effect on the body, chromophores receive light energy and convert into chemical energy, which causes local and/or systemic biological reactions in the organism. The absorption of red and infrared wavelengths occurs mostly in the mitochondria and directly interferes with cellular respiration, overarching input of oxygen, resumption of the respiratory chain, and, as a result, acceleration of intracellular adenosine triphosphate (ATP) synthesis. Given that muscle activity necessitates a high level of energy expenditure, resources that enhance ATP synthesis are thought to have a good impact on functional performance.

Researches, have been conducted to study the therapeutic effects of low-level laser therapy (LLLT). The ability of light energy to be absorbed by cells, promoting or inhibiting intracellular processes depending on the parameters utilized, has been attributed to the mechanism of action of this therapy on tissues.[22] Recent animal research[23,24] have also shown the efficiency of phototherapy in reducing muscle injury, supporting prior findings in humans on delayed onset muscle soreness and blood indicators.[25] The anti-inflammatory benefits of phototherapy, such as its potential to lower reactive oxygen species release,[26] boost antioxidant capacity,[27] and improve mitochondrial function, may explain these hopeful results in muscle functions.[28] Many studies reported the positive effect of laser therapy on muscle performance,[20] muscle damage,[17] muscle strength,[21] muscle fatigue,[18] muscular hypertrophy[19] and muscle gain[29] in symptomatic and asymptomatic individuals.

Low-level laser therapy has showed promising tool to prevent hamstring injury in different population. Single application of photobiomodulation device of contains 152 infrared LEDs (880 nm) over an posterior thigh area of 252 $cm^2$ (10.5 cm × 24 cm) for 60 s, totalizing an energy dose of 300 J in each hamstring muscle shows positive effect among soccer players.[30] Most of the published studies on laser therapy are done with the low level laser therapy and some of the published reports have questioned the effects of low level laser therapy. The issue of fluence level and therapeutic dose has been a major flaw in low-power laser investigations. Because of the use of subthreshold power outputs and power densities, insufficient treatment durations, and

varying treatment frequencies, clinical researchers believe that studies utilizing low-power laser therapy have not been able to find good therapeutic outcomes of the modality. Class III low-power lasers have energy outputs of 1 to 500 mW, and class IV high-power lasers have energy outputs more than 500 mW. In low level laser therapy, the increase in the rate of temperature is not significant for superficial tissues, however high-intensity laser therapy (HILT) produce very short bursts and duty cycle and produce greater radiation in target tissue with very mild histological risks and provide effect to the deep tissues and structures. HILT effective over low level laser therapy because of high power pulsed emission and have a photochemical effect also improves muscle performance by micro-massaging the soft tissue structure. However, no research reported the therapeutic effect of HILT to improve the hamstring muscle length.

**Need of the Study:**

Various thermal and non-thermal therapeutic techniques have been shown to improve hamstring flexibility in people with hamstring tightness in the past. However, to our knowledge no research has been done on the effectiveness of HILT in improving hamstring flexibility in people who have tight hamstrings. However, there is no research had been conducted on HILT to determine the proper parameters necessary to increase flexibility. This study will be helpful in future perspective to manage the hamstring muscle length (HML).

**Research Question:**

There is definite need to establish HILT protocol to determine whether this intervention will have significant effect on hamstring muscle tightness?

**Aim of the Study:**

To evaluate the effects of HILT on HML in young adults.

**Objectives of the Study:**

To study the effect of 2-week high intensity laser therapy in improving the hamstring flexibility in individuals with hamstring tightness.

**Research Hypothesis**

**Null Hypothesis**

There will be no significant changes in hamstring muscle length after application of HILT between the experimental and control groups.

**Alternate Hypothesis**

There will be significant changes in hamstring muscle length after application of HILT between the experimental and control groups.

## Chapter 2: Review of Literature

### Hamstring Tightness. Anatomy and Biomechanics:

The three posterior thigh muscles, as well as the tendons that form the area behind the knee, are referred to as the hamstrings. The biceps femoris, semitendinosus, and semimembranosus muscles make up the hamstring muscle complex. The adductor magnus muscle is considered a hamstring muscle by certain anatomists. The adductor magnus muscle is divided into two sections: a pubofemoral portion with a muscular origin from the ischiopubic ramus and inserts on the lower gluteal line and linea aspera, and also an ischiocondylar portion with a tendinous origin out from inferior ischial tuberosity and inserts upon that femoral adductor tubercle after an almost vertical course.[31] The pubofemoral region of the hip is used to adduct and rotate the hip medially, while the ischiocondylar section is used to extend the hip. Researchers interpret the ischiocondylar component to be part of the hamstring muscle unit because it has the same innervation and activity as the major hamstring tendons.[32] The ischiocondylar part of the adductor magnus is referred to as the "mini hamstring." The adductor magnus mini hamstring tendon could have a number of clinical concerns. The location of the remaining proximal hamstring tendons can be determined by using its usual origin as a landmark for both radiologists on MRI and surgeons intraoperatively. This is certainly relevant for

surgeons who want to restore hamstring muscle function by reattaching the avulsed tendon to its original position.[33]

The hamstring muscles are lengthy, cross-sectional muscles that cross two joints. During trunk flexion, they keep the pelvis from hyperflexing against gravity. During walking, hamstring muscles also govern hip extension. When the body's gravity centre is anterior to the transverse axis, the hamstring muscles contract heavily to keep the body straight against gravity. Hamstring muscle rotate hip internally when the hip is fully extended, whereas Biceps femoris rotates the thigh externally. Evidences reported that increasing hamstring flexibility would decrease lower extremity overuse injuries.[34]

The hamstrings, specifically the biceps femoris, have been identified to play a key role in knee biomechanics, and hamstring tightness has been linked to knee overuse problems. A study reported high correlation between lateral hamstring muscle tightness and lateral knee pain. They recruited 40 patients affected with lateral knee pain. Pain intensity was assessed with the visual analogue scale and muscle tightness was assessed with ober's test and hamstring tightness test. The lateral knee pain was found to have a strong positive correlation with lateral hamstring and/or iliotibial tightness ($r = 0.83$, $p=0.01$). Manual treatment and stretching exercises help to treat the lateral knee pain, and the hamstrings and iliotibial band regained their normal flexibility.[35] The hamstring's many attachments allow it to influence function across the pelvis

and lower extremities. The hamstrings influence pelvic tilt and rotation, sacral rotation, and hip extension and rotation in addition to knee flexion and extension.[36] It has been suggested that most of the hamstring injuries occur in sports during late swings of gait when knee is extended and hip is flexed. According to research findings, the contralateral hip flexors (iliopsoas) have just as much of an impact on hamstring stretch as the hamstrings themselves. This is due to the iliopsoas' ability to create an increase in anterior pelvic tilt, which needs more hamstring strain. The abdominal obliques and erector spinae, as well as other proximal muscles working on the pelvis, have a significant impact on hamstring stretch. The hamstring mechanics were influenced far less by the more distal muscles operating around the knee and/or ankle. This demonstrates how neuromuscular regulation of the trunk and pelvic muscles can influence the likelihood of hamstring strain injury.[37]

The hamstring muscle complex's primary role is to contract eccentrically, absorbing kinetic energy and protecting the knee and hip joints. Unless a muscle contracts while being stretched passively, it is known as eccentric contraction. Because the stress produced on by stretch is overlaid on the tension brought on by contraction, injury is more likely to occur during eccentric contraction than concentric contraction. Following strong eccentric exercise, magnetic resonance imaging reveals changed muscle signal intensity, which is absent following concentric exercise.[38] Muscular strain is a type of muscle disruption that ranges from mild (delayed onset

muscle soreness) to severe total tear or avulsion.[39,40] Because it inhibits the muscle's ability to absorb force, any condition that reduces its ability to contract makes it vulnerable to harm.[32]

**Hamstring AND Back Pain:**

Reduced hamstring flexibility is linked to patella tendinopathy and patellofemoral pain, as well as hamstring injury and muscle damage symptoms after eccentric activity. Because the hamstring muscle attaches to the ischial tuberosity, hamstring tension is linked to a posterior rotation of the pelvis when standing. Low back pain is caused by hamstring muscle tightness, which promotes posterior pelvic tilt and a decrease in lumbar lordosis. A cross sectional study done on 18-25 years old 50 normal college going adults to find out prevalence and severity of hamstring tightness. Active knee extension (AKE) test was used to measure the hamstring tightness in both the lower extremity. Participants were evaluated supine on a platform with both lower extremities extended. Both anterior superior iliac spines were aligned with the equipment' vertical bars. A band across the lower part of the thigh was used to attach the lower extremity that was not being measured to the plinth. The participants were instructed to stretch their hips until their thighs came into contact with the horizontal bar. Participants were requested to extend their leg as far as possible while keeping their foot relaxed and sustain the position for around 5 seconds while maintaining contact between the thigh and horizontal bar. The goniometer arms were positioned along the femur and fibula, and a standard universal goniometer was put over

the previously indicated joint axis. The degree of knee flexion from terminal knee extension was used to calculate the AKE. It was found that right side of the hamstring is more affected than left side in both male and female. Overall reported prevalence is higher in female (96%) than males (04%).[41] Flexibility, a characteristic that increases both stability and optimal physical activity, determines an individual's ability to move smoothly.

**Prevalence of Hamstring tightness AND Injuries:**

Muscle tightness is caused by a reduction in the muscle's capacity to deform, which reduces the range of motion at the joint on which it functions. Hamstring tightness is defined as an inability to accomplish greater than 160° of knee extension with the hip in 90° of flexion. Tight hamstrings lead to hamstring injuries, which are the most prevalent type of injury among athletes. A study done to find out the prevalence of hamstring muscle tightness in University of Peradeniya on 178 male athletes aged between 20-28 years. It is reported in this study that athletes who participate in contact sports had much greater rates of hamstring tightness than athletes who participate in athletics, martial arts, and other sports (swimming, weight lift ing, volley ball, baseball, hockey, cricket, and tennis). Hamstring tightness were assessed among all the athletes participating in different categories of sports by active knee extension test in both the knees and angle is measures by goniometry. However, no significant difference of hamstring

tightness reported with body height, femur length, warm up duration and cool down duration. Among the athletes hamstring tightness is major concern to prevent and manage the tightness.[4]

Physical fitness is essential for healthy health. One of the despite the rise in childhood obesity in the previous two decades is a lack of physical fitness. The capacity to move a joint through its full range of motion is known as flexibility. It refers to muscle flexibility as well as non-contractile tissues including the joint capsule, ligaments, and tendons. Injury to the musculotendinous unit might result in pathological abnormalities at the joint. Pelvic rotation is made possible by flexible muscles. Reduce disc compression and avoid overstretching the muscles. As a result, when those with low hamstring extensibility do a maximal trunk flexion with their legs extended, they have more spinal flexion and a posterior pelvic tilt. A study done on 100 college going healthy adults to establish the prevalence of Hamstring tightness and find out the correlation between right and left Hamstring length in both genders. Hamstring tightness were assessed by sit and reach test. The subject was asked to sit on the sofa in a long sitting position. He kept leaning forward, trying to touch his toes with his knees extended. Use an inch of tape to measure from middle finger to toe. The measurement is recorded in inches on the left and right limbs of both sexes. There is a strong correlation between right and left hamstring length in both groups, but no correlation between right and left hamstring length between groups. Male participants had tighter left hamstrings, while female subjects had tighter right hamstrings.[5]

**Hamstring tightness and its effect on age and gender:**

The loss of joint range of motion is typically related with ageing. However, there is no solid evidence in the literature that this association always exists and that the reduction is statistically and clinically significant. Between young subjects (25-39 years old) and the oldest age group, Roach and Miles in their study found a 3° to 5° decrease in mean active hip and knee mobility (60-74 years of age). With the exception of hip extension, these reductions accounted for less than 15% of the total range of motion.[42]

It has been suggested that the loss of joint range of motion and muscle flexibility with age is due to age-related molecular cross-linking of collagen molecules, which can affect the mechanical properties of collagen at the cellular level. Furthermore, the loss of joint range of motion or muscle flexibility is likely multifactorial, and it is influenced by a generalized drop in activity level as people get older.

Hamstring muscle length (HML) has a statistically significant gender effect, with women having more than their male counterparts. Passive straight leg raise (PSLR) is around 8 degrees lower in males than in women, and popliteal angle is about 11 degrees lower in men. A Physiotherapist could predict HML to differ between men and women based on general joint range of motion statistics, with women having more HML. A study of ten men and ten women in four age groups spanning 22 years (range, 70-92 years) found statistically significant differences

in PSLR for the primary impacts of gender and age. HML was higher in women than in males, and both men and women showed a continuous decrease in HML as age increases. The study only looked at men and women between the ages of 70 and 92.[43]

A study done to determine whether age and gender would have significant influence on hamstring tightness in apparently healthy individuals. They have studied among 240 healthy subjects aged between 5 and 59 years and body mass index, height, weight, limb length and hamstring tightness using active knee extension test was assessed. They found that hamstring tightness was prevalent in all of the age groups investigated, and that it tended to get worse as people became older. When compared to the age range 40-49, it was much lower in the 50-59 age group. According to the data, hamstring tightness develops in early childhood in this setting and tends to worsen with age. This supports previous findings that juveniles have less hamstring tightness than adults. Changes in elasticity and a loss in physical activity have been blamed for the increasing decline in flexibility with age. Males had more hamstring tightness than females across all age categories, according to the findings. This supports previous research that females of all ages have more trunk/hip flexibility than males.[1]

**Hamstring tightness AND Sedentary life style:**

Muscle injury is caused by a lack of flexibility, which is especially true for the hamstring muscles. Children spend the majority of their school days engaged in various classroom activities

such as reading, writing, drawing, and so on, and are more likely to develop poor posture as a result of sitting for lengthy periods of time. Hamstring muscles were assessed by using active knee extension test and sit and reach test. AKET performed an active knee extension test on the hip stabilizer and measured the angle of tension of the hamstrings with a universal semicircular goniometer. A sitting and stretching test was performed. Because the hamstring muscles bend the knee, long periods of sitting can cause this muscle group to shortened.[44] In a school in Spain, where about 18-38 percent of students had reduced hamstring flexibility. The purpose of this study was to examine the standard-related validity of the sitting posture test (SRT) and the modified sitting posture test (MSRT) to evaluate the hamstring flexibility measured by the goniometric method through the passive straight leg elevation test (PSLR). as well as. To, determine whether MSRT is a more effective test than SRT. The test is carried out using a special box with a sliding rule. The height of the box is 33 cm. Participants sit on the floor with their legs fully extended at shoulder height and their feet resting on the box. With one hand in the other, with the knee fully extended, the participant advances slowly (without jerking) as far as possible, slides both hands over the top of the ruler, and holds the final pose for at least two seconds. In centimeters The SRT score is recorded as the final position of the fingertip on or towards the ruler. The higher the score, the better the performance. An extension of 15 cm corresponds to the position of the foot on the box. If the participant cannot touch the front of the box with their fingertips, the score is negative and the score is "0". The test is performed twice

and the average value is maintained. Modified stretch and stretch test MSRT is determined by correcting the proportional difference between arm and leg length by measuring the distance between the toe and the box according to the procedure described by Hoeger. Participants sit on the floor with their head, back and hip against the wall (hip joints are at 90°), their legs are fully extended, and their feet are resting on the box. In this position, the participant needs to place one hand on the other and extend it to the level of the measuring scale, keep the head, back, and hips in contact with the wall, and only perform shoulder blade abduction. Then, the distance between the toe and the box is measured as the distance between the fingertip and the point where the foot rests on the box (point 15 on the scale). The MSRT score is calculated using the following formula: MSRT score = toe box distance (cm) + (SRT score-15 cm). The test is performed twice and the average value is maintained. The standard measure of hamstring flexibility is determined by performing the maximum PSLR in each limb. This test was chosen because it is widely accepted as a measure of hamstring flexibility and has high reliability (0.95-0.99). The handheld goniometer is used to measure the angle of the hip joint. When the participant lies supine on a firm surface, the axis of the goniometer is aligned with the axis of the hip joint. The tester aligns the fixed arm with the lower back and the movable arm with the femur. With the knee straight, the participant's leg moves passively in hip flexion until both the participant and the evaluator feel tense. The score is the maximum angle (degrees) obtained at the point of maximum hip flexion. The hamstring flexibility score was determined as the average of two measurements for

each leg. The score of each leg is recorded to the nearest degree. A high percentage of students had limited lumbar and hamstring flexibility.[45] Hamstring tightness has been linked to lower back discomfort in children, and children with tight hamstrings have a higher chance of developing low back pain as adults.[46]

Obesity has a negative impact on physical fitness. According to studies, health-related fitness indicators like BMI, body composition parameters, and flexibility can fluctuate depending on obesity and physical activity levels. Despite the fact that there is information in the literature on the importance of hamstring flexibility in young children and the negative consequences of hamstring tightness. A study of 9-11 year old children was conducted to determine the prevalence of hamstring tightness, analyze the relationship between hamstring flexibility and physical activity level, BMI, and compare the hamstring flexibility scores amongst subjects of different obesity and physical activity levels. The passive straight leg raise test was used to assess hamstring flexibility. According to the data, hamstring stiffness was found in almost half of the individuals from both nations. This finding underscores the need of assessing and treating hamstring tightness at an early age. The results showed that those who engaged in a lot of physical exercise had considerably greater hamstring flexibility scores. According to the findings, 43.4% and 44.2% of Malaysian subjects have hamstring tightness on their dominant and non-dominant sides, respectively; 51.2% and 51.9% of Sri Lankan minors have hamstring tightness on their dominant and non-dominant sides, respectively.[47] In both Nations, participants

in the “high” physical activity category had considerably higher hamstring flexibility ratings than those in the “low” physical activity category. Hamstring flexibility and physical activity level were found to have a significant positive weak connection among Malaysians. In today's world, young children are rarely encouraged to participate in physical activity. They have fewer opportunities to burn calories. Children spend the majority of their time watching television, playing video games, and using other electronic gadgets and media, and consequently spend the majority of their time seated. This habit of leading a sedentary lifestyle and sitting in a seated position might cause hamstring muscle stiffness. This hamstring muscle tension could be a hidden source of discomfort for youngsters, preventing them from participating in physical activities.

**LASER Therapy:**

Lasers (light amplification by stimulated emission of radiation) are devices that produce electromagnetic radiation that is relatively uniform in wavelength, phase, and polarization, and were first described in the form of a ruby laser by Theodore Maiman in 1960. A laser is defined as a light or radiation energy source. The Low Level Laser (LLL) is a type of laser that has non-thermal effects on biological systems. Mester et al work's in 1967 was the beginning of this field of research. Lasers have nonthermal effects on mouse hair development, according to the researchers. The application of light to a biologic system to promote tissue regeneration, reduce

inflammation, and relieve pain is known as low-level laser therapy (LLLT). Unlike other medical laser techniques, LLLT uses a photochemical effect to create a chemical change rather than an ablative or heat mechanism. Photons must be absorbed by electronic absorption bands belonging to some molecular photo-acceptors, which are called chromophores, according to the first law of photobiology. Light around 650 nm to 1200 nm has the greatest efficient tissue penetration.[48]

HILT employs a waveform with regular peaks of amplitude elevated value and distance between them to reduce thermal accumulation and induce photochemical and photothermal effects in deep tissue that increase blood flow, vascular permeability, cell metabolism, and tissue photomechanical level, with very short application times. This type of radiation is distinguished by a specific absorption that occurs in all directions (scattering phenomenon), enhancing mitochondrial oxidative response and adenosine triphosphate, RNA, or DNA creation (photochemistry effects), and resulting in tissue stimulation (photobiology effects).[49]

High-Intensity Laser Therapy (HILT) is a novel laser therapy method that has recently gained interest in various acute or chronic conditions. This method is easy, non-invasive, and painless, and it achieves movement of a large region on the body's surface while also effectively stimulating deep tissue. A number of studies have evaluated short-term and long-term effects of low-level laser therapy (LLLT), but to date until our knowledge no studies have been conducted

on HILT to muscle tightness. However, HILT has a proving effects on pain,[50,51] inflammation,[52] sports injuries[53] and various other conditions.[54]

## Mechanism of HILT

High-intensity laser therapy (HILT) or high-power laser therapy (HPLT) uses laser light with a wavelength of approximately 1000 nm (mostly 1064 nm) in shortened pulses to generate a photomechanical wave in a tissue (with a typical energy of 0.51–120 J/cm$^2$ and a laser power output of up to 12 W) that produces a completely new therapeutic quality. This causes the diseased tissue to heat up (by about 2°C–3°C) and the nociceptors and other nerve terminals to be mechanically stimulated. As a result, the nervous system's pain pathways are blocked, resulting in immediate pain alleviation. HILT also decreases inflammation and improves metabolism in wounded tissue by stimulating blood and lymph circulation locally, resulting in less edema and higher blood supply. As a result, the damaged tissue heals, and a powerful yet nonaddictive pain reliever is delivered.[55,56] HILT appears to become a more exciting branch of specialised physiotherapy than, low-level laser therapy (LLLT), a more well-known and longer-used method with similar properties but lower treatment parameters (energy dose in the range of 0.01–100 J/cm2 with a laser power output of 0.001–0.1 W; wavelength usually near 500–600 nm).[48] Due to the higher laser energy, the therapeutic effect on the diseased tissue is substantially greater (depth up to 10 cm) with HILT. ***(Figure 2.1)***

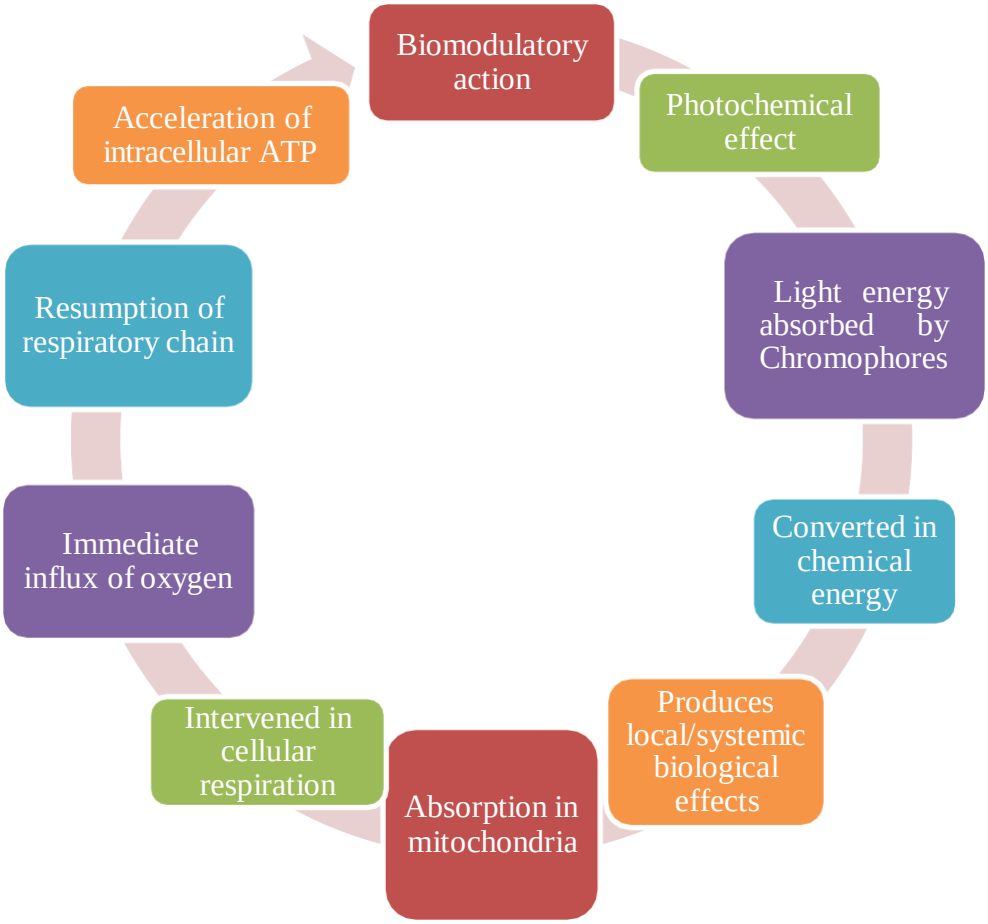


**Figure 2.1: Flowchart of Mechanism of High-intensity laser therapy**

**Laser Therapy AND Muscle Function:**

Fatigue development is a complicated and multifaceted process comprising physiological, biomechanical, and psychological elements that is influenced by a number of factors such as the types and intensity of exercise, the muscle groups involved, and the local physical and biochemical environment. The ability to contract skeletal muscle and the ability to endure fatigue development are also determined by age and gender. Oxidative stress and reactive oxygen species (ROS)—signaling agents are generated during high-intensity exercise in anaerobic settings. ROS impair mitochondrial function, which is known to induce muscle cell depolarization and diminished force, among other things. After severe sporting activity, muscular injury and skeletal muscle fatigue can occur.

A study was done to find out the effect of LLLT (810 nm) affected DOMS, muscle proteins in the blood, and muscle performance 48 hours following knee extensor eccentric exercise. 36 healthy male aged between 19 and 35 years recruited for the study and assessed with Blood sampling (LDH and CK), quadriceps soreness evaluation (VAS); and, muscle function evaluation (MVC). The maximum torque value achieved among three 5-s maximal voluntary contractions (MVC) at 60 degrees of knee flexion was used to evaluate muscle function. A two-minute rest period was observed between each MVC to reduce fatigue. The muscle discomfort of the volunteers was measured using a visual analogue scale (VAS). The same researcher

prompted volunteers to perform a sub-maximal voluntary isometric knee extensor contraction in a standardised manner during each evaluation, marking a vertical line at the scale point that best reflected their muscular soreness. The VAS's 100-mm horizontal line had no markers or numbers, only the words "no soreness" at the start and "severe soreness" at the conclusion. The distance between the initial point line (0 mm) and the point marked by the participant was used to quantify the soreness. Laser therapy treatment was performed prior to eccentric exercise, probe was held stationary in skin contact at a 90-degree angle with slight pressure on six application points. Irradiation sites were defined by palpation of muscle bellies: two points on the distal region of vastus medialis, two points on the distal region of vastus lateralis, and two points on the central region of rectus femoris. Each sites received 30 seconds of LLLT or placebo therapy. In this method, 30 J each point (6 J per diode) was applied, totaling 180 J for the entire quadriceps muscle. Post intervention all the outcomes were analyzed. There was no group by time interaction in the VAS data, indicating that the treatments had equivalent effects on muscular soreness. Subjects who received LLLT before eccentric exercise showed a reduction in some indirect markers of muscle damage, including a smaller increase in LDH levels 48 hours after exercise, a smaller increase in CK levels 24 and 48 hours after exercise, a smaller decrease in force immediately after exercise, and a recovery of muscle function 24 and 48 hours after exercise.[57]

A study was done to determine whether low level laser therapy is able to optimize the effects of chronic strength training. The study included 36 men (20.82.2 years old), all of them were clinically healthy and engaged in a beginner and/or moderate level of physical activity training. The leg-press exercise with a load equal to 80% of one repetition maximum (1RM) in the leg-press test was performed for training group (TG) and training and laser group (TLG) patients throughout a 12-week period. After each training session, the TLG subjects received LLLT to the quadriceps muscle in both lower limbs. A total of 50.4 J of LLLT was administered over 140 seconds using an infrared laser apparatus (808 nm) with six 60 mW diodes each with contact method of application. The 1RM leg press test and the isokinetic dynamometer test were used to determine muscle strength. Thigh perimetry was used to determine the muscle volume of the dominant limb's thigh. Results suggested that Strength training combined with LLLT may be superior to strength training alone, according to the findings of this study.[21]

Skeletal muscle fatigue is defined as a reduction in a muscle's ability to generate and maintain force during activity. Skeletal muscle fatigue is defined as a failure to maintain the initial level of exercise in submaximal activities. Muscle fatigue is a multidimensional physiological and biomechanical process including muscle fibre type, intensity and length of activity, and oxidative stress. Low-level laser therapy and light emitting diode therapy have been demonstrated to delay skeletal muscle exhaustion and improve muscle recovery when used before exercise. Laser therapy protocol with 30 J per point, 12 points on the lower limb

(gastrocnemius, hamstring and quadriceps) total 360 J for 30 seconds on each point (360-second total treatment on each leg) was applied to evaluate the effect of exercise performance, oxidative stress and muscle condition. Authors reported the improvement of the performance in the aerobic exercise, oxidative stress and the biochemical markers of muscle damage in the experimental group.[20]

Strength training activities are one of the most essential strategies for reducing the negative effects of ageing on muscle tissue, improving contractile muscle characteristics, encouraging the growth of myofibrils and increasing the cross-sectional area of muscle fibres. However, some factors must be considered before prescribing strength exercises to this population, such as bodily fragility as a result of increased oxidative stress, which increases injury sensitivity and fatigability. Some authors have established the therapeutic effects of low-level laser treatment (LLLT) combined with physical exercise training in various groups based on these statements. LLLT can help restore cellular homeostasis by boosting the mitochondrial respiratory chain, increasing adenosine triphosphate (ATP) generation, and protein and enzyme synthesis. All of these features cause muscle tissue to be stimulated, delaying muscle exhaustion, lowering lactate levels, and boosting muscle strength in exercised people (young population). Study reported the effects of the laser association with muscle training on strength training among 48 clinically healthy woman. The quadriceps femoris muscle was irradiated with placebo or active laser irradiation (depending on the group—TG or TLG) immediately after each training

session. The laser utilised was an infrared AsGaAl laser (= 808 nm). Authors concluded that there was an improvement of the performance and in the lactate indexes in laser group.[29]

**Different methods of assessing Hamstring muscle length:**

Flexibility, on the other hand, is a physiological notion that includes components from both joint and soft tissue structures and is described by, but not consistent with, range of motion (ROM) assessments (e.g., nerves, muscles). Hamstring tightness, which is frequently defined as a loss of ROM along with a sensation of tightness in the posterior thigh, has been linked to hip dysfunction in people of all ages. Musculoskeletal insufficiency or imbalance, neurological stress, and lumbopelvic dysfunction are all possible causes of apparent hamstring tightness. Hamstring tightness is commonly examined in a variety of populations, including children, athletes, and the elderly. The active knee extension test, passive straight leg raise test, V-sit and reach test, and finger to floor distance test are all commonly used to detect hamstring tightness, although each of these tests may be evaluating the problem using distinct constructs. A study done on 58 clinically healthy population to establish the relationships between four test of measuring apparent hamstring muscle tightness. The study demonstrate a lack of common variation among the majority of the assessments used, implying that each assessment may be evaluating a distinct underlying construct of apparent hamstring tightness, such as hamstring muscle length, neural tension, and/or lumbopelvic stability, among others.[58]

The active knee extension test is an active test that involves movement at the knee joint, and it is generally regarded as safe because the patient determines the movement's end point. Furthermore, when conducted within 30 minutes, the AKE test with a metal rig and straps to limit pelvic and leg movements (as a stabilising apparatus) had a good intrarater correlation coefficient. A study was conducted to examine the interrater and intrarater reliability of the AKE test for hamstring flexibility evaluation in healthy volunteers utilizing a PVC stabilizing apparatus. The study demonstrated that the AKE test may be simply conducted by a single assessor using a basic stabilising device and a universal goniometer. The dominant and nondominant knees had interrater reliability (ICC) scores of 0.87 and 0.81, respectively. Standard error of measurement of the equipment reported for the dominant knee is $3.5^0$ and $3.8^0$ for the non-dominant knee.[59]

The passive bilateral SLR test, the passive toe-touch test, the active unilateral SLR test, and the passive unilateral SLR test are all available to quantify hamstring muscle tightness. All of these tests use the angle of hip flexion with the knee extended to determine hamstring tightness. Because the SLR test produces extension of the sciatic nerve and accompanying tissues, it is also commonly employed as a neurological test. Furthermore, measurements of the SLR/horizontal angle do not give a good indicator of hamstring length, according to a study that used cinematographic analysis of the passive unilateral SLR test. Alternative methods of hamstring tightness measurement, such as the angle of knee flexion following active knee

extension with the hip stabilized at 90 degrees, should be examined. The active knee extension test has a high reliability co-efficient, which is a more objective measure of hamstring tightness, according to the study done by Gajdosik R.L et al.(1983).[60]

**Table 2.1: Studies related to laser therapy in improving muscle function**

| Author (Year) | Population | Intervention | Comparison | Outcomes |
|---|---|---|---|---|
| Dornelles M.P. etal, (2019)[30] | 12 male amateur soccer players | Prior to the each simulated soccer match with the irradiation beam of 60 sec/point total 300 J 880 nm of continous mode on posterior thigh with flexible pad. | Placebo therapy | Quadriceps concentric peak torque, Hamstring eccentric peak torque, H:Q torque ratio, countermovement jump test |
| Ferraresi C. etal, (2010)[21] | 36 clinically healthy men | Low level laser therapy was applied to the quadriceps muscle of both lower limbs immediately after the end of training session. 808 nm with six diodes of 60 mW each a total energy of 50.4 J was administered over 140 s. | Training only and control group | 1RM leg-press test, isokinetic dynamometer test, muscle volume of the thigh of the dominant limb was assessed by thigh perimetry. |
| Marchi T.D. etal, (2011)[17] | 22 untrained male volunteers | LLLT (810 nm, 200 mW, 30 J in each site, 30 s of irradiation in each site) using a multi-diode cluster (with five spots - 6 J from each spot) at 12 sites of each lower limb (six in quadriceps, four in hamstrings, and two in gastrocnemius) | Placebo | Exercise performance, superoxide dismutase and catalase, and the markers of muscle damage creatine kinase and lactate |

| | | | | |
|---|---|---|---|---|
| | | | | dehydrogenase. |
| Dundar U. etal, (2014)[51] | 76 female patients with a diagnosis of myofascial pain syndrome of the trapezius muscle | Total energy delivered 1,060 J in three phases of treatment. In one session (first phase, 500 J; second phase, 60 J; and third phase, 500 J) was 1,060 J. High intensity laser therapy was applied once a day for 15 days during a period of 3 weeks. | Placebo | Visual analogue scale, Active range of motion, neck disability index, short-form 36 health survey |
| Fiore P. etal, (2011)[49] | 30 patients with low back pain | Wavelength of 1 064 nm, total dose of energy 2600 J, in 3 stages for 10 minutes on lower back region. Maximum energy for single impulse of 150 mJ, average power of 6W, fluency of $760mJ/cm)^2$. | Ultrasound therapy | Visual Anlogue scale and Oswestry low back pain disability questionnaire |

**Summary of review of literature:**

To our knowledge, there is lack of published research on effectiveness of high intensity laser therapy to reduce the muscular tightness; however, low-level laser therapy is proved effective in improving the muscle function. Previous studies on high intensity laser therapy have shown to be effective in reducing pain, inflammation in non-invasive, painless way. High-intensity laser therapy (HILT) generates a photomechanical wave in a tissue (with a typical energy of 0.51–120 J/cm2 and a laser power output of up to 12 W) that produces a completely new therapeutic quality by using laser light with a wavelength of approximately 1000 nm (mostly 1064 nm) in shortened pulses. This causes the tissue to heat up (by roughly 2°C–3°C) and mechanical stimulation of the nociceptors and other nerve terminals. By boosting blood and lymph circulation locally, HILT also reduces inflammation and improves metabolism in injured tissue, resulting in decreased edema and increased blood flow.

To measure hamstring muscle tightness, you can use the passive straight leg raise test, passive toe-touch test, active straight leg raise test, hip-knee 90-90 test, and active knee extension test. To detect hamstring tightness, all of these tests involve the angle of hip flexion with the knee extended. The straight leg lift test is often used as a neurological examination because it causes expansion of the sciatic nerve and surrounding tissues. Various hamstring tightness assessment methods should be investigated, such as the angle of knee flexion following active knee

extension with the hip stabilized at 90 degrees. The active knee extension test, which is a more objective measure of hamstring tightness, has a high reliability co-efficient.

# Chapter 3: Methodology

**Study design:** Pre-test Post-test Randomized, Sham Controlled Trial will be used

**Study location:** Physiotherapy Outpatient department (OPD)

**Study setting:** Exercise therapy Lab, Physiotherapy OPD

**Study participants:** Young adults

**Sampling:** Purposive sampling

**Subject selection criteria:**

**Inclusion criteria:**

Asymptomatic young adults

Both gender

Age 18-30 years

Tightness of hamstring muscles

**Exclusion criteria:**

Any other musculoskeletal disorder

Any disc pathology

Any nerve root irritation

Any surgical history or trauma

Malignancy

Pregnancy

Sensory dysfunctions

Cardiac pacemaker

**Outcome measures:**

**Flexibility:**

Active knee extension test

Sit and toe touch test

**Materials to be used:**

Stationaries

High-intensity laser therapy device

Measuring tape

Universal Goniometer

**Procedures:**

**Ethical Statement**

Research Advisory Committee of Maharishi Markandeshwar Institute of Physiotherapy and Rehabilitation, Maharishi Markandeshwar (Deemed to be University), Mullana, Ambala has approved the protocol of the study on August 10th 2021. The study was approved from Institutional Ethics Committee of Maharishi Markandeshwar Institute of Medical Sciences and Research, Maharishi Markandeshwar (Deemed to be University) (MMDU/IEC/2151 on 13/10/2021). The research will be carried out in strict conformity with the Helsinki Declaration principles, as revised in 2013. The research will also adhere to the ethical principles developed by the Council for International Organizations of Medical Sciences (CIOMS) in partnership with the World Health Organization (WHO) in 2016, titled "International Ethical Guidelines for Health-Related Research Involving Humans." After obtaining ethical approval from the institutional ethics committee, a unique Universal Trial Number (UTN) U1111-1269-9595 was obtained for the study. The study protocol was uploaded in open access clinical trial registry platform, Clinical Trials Registry (NCT05077761) (https://clinicaltrials.gov/ct2/show/ NCT05077761) Registered on 01st October 2021, approved by WHO's International Clinical Trials Registry Platform (ICTRP) and International Committee of Medical Journal Editors (ICMJE). Before participants are enrolled in the study, they will be asked to sign a written informed consent form.

**Participants recruitment and allocation**

The study will be Pre-test Post-test Randomized, Sham Controlled Trial. This study aims to recruits the young adult participants age between 18-30 years from a teaching institute. We will include participants with hamstring muscle tightness confirmed by active knee extension test.

For recruitment, we will organize the screening programme in teaching institutes and assess the young adults according the inclusion criteria.

**Sample size calculation:**

Sample size was calculated from previous study[61] with value z-alpha= 1.96, z-beta= 1.28, standard deviation of $16.02^0$ and expected minimal clinical important change (d)= $12^0$, considering 30% dropouts resulting in a sample size of 50 subjects of each group. The number of participants was also estimated using the free-access software G*Power ver. 3.1.9.7 software (Heinrich- Heine-Universität Düsseldorf, Düsseldorf, Germany; http://www.gpower.hhu.de/).[62] The Active knee extension test (AKET) is considered a primary outcome in the current study, so results reported by D.M. Medeiros et al.[61] were used in the sample size estimation. Power was set as 90%, with an alpha level of 5%, estimated effect size of 0.62, considering 30% dropouts, resulting in a sample size of 68 subjects per group. ***(Figure 3.1)*** By considering both the methods of sample size estimation we adopted higher number of samples analyzed by G*Power ver. 3.1.9.7 software (Heinrich- Heine-Universität Düsseldorf, Düsseldorf, Germany; http://www.gpower.hhu.de/). Resulting total number of sample size 136 in both the groups.

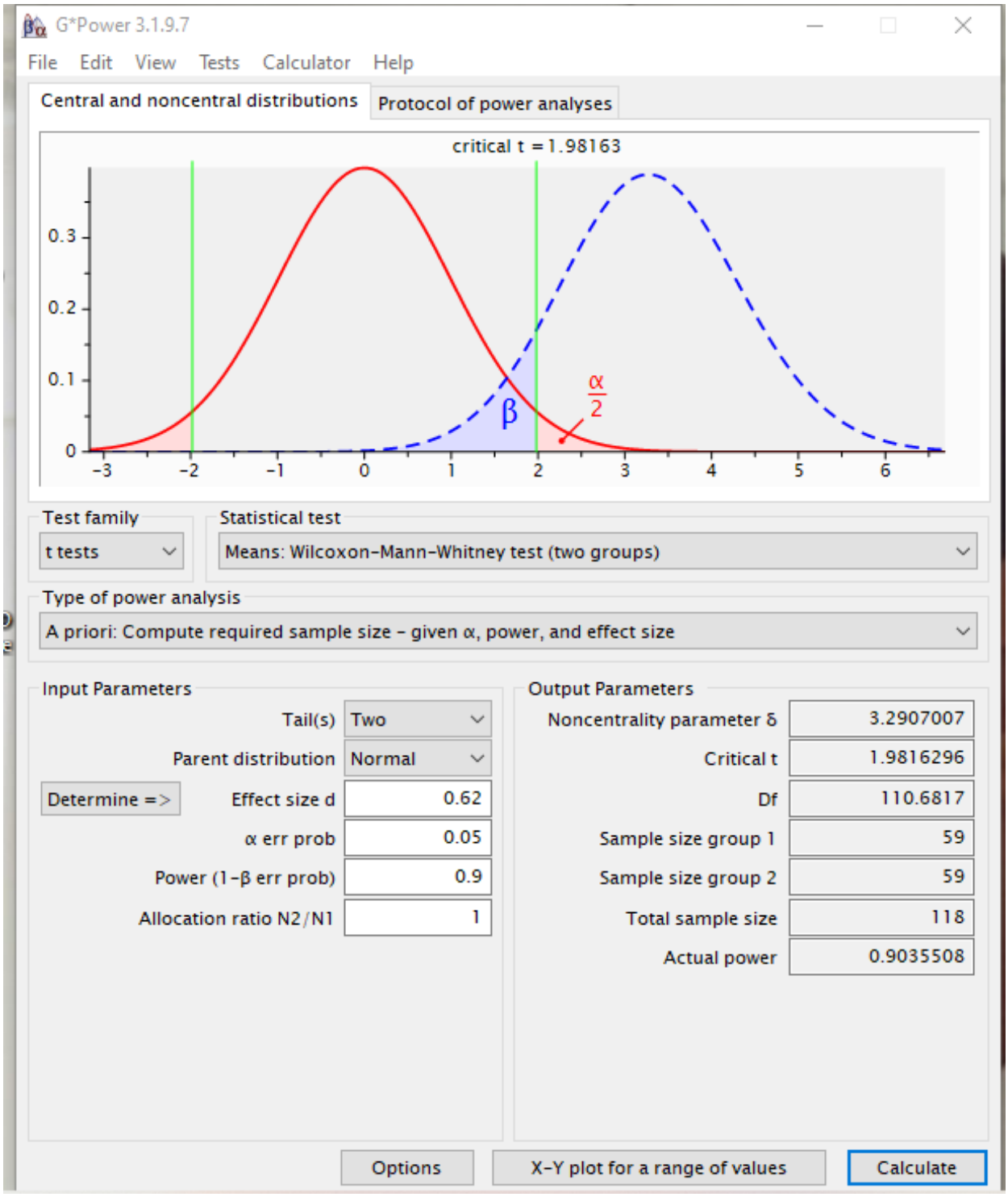


**Figure 3.1: G* Power Sample Size Calculation**

**Randomization:**

136 patients will be selected based on the inclusion criteria for the single, blind two-group pretest-posttest randomized controlled design. Demographic data will be recorded for all the patients. The patient with HMT will be allocated in two groups, active HILT group and sham HILT group by block randomization technique. According to it, there will be four blocks, with the matrix design of 4 × 34, where 34 being rows. Each row could have four blocks, with one chit (SNOSE - sequentially numbered, opaque sealed, envelopes) in each block containing either the name of active HILT or sham HILT. Total four chits (2 chits for each group) will be assigned to each row and then patient with HMT will be allotted to one of the two group based on the randomly chosen chit (SNOSE). Once the entire first row will be allotted, then the next row block will be opened for enrolment. The advantage of this method of randomization is that the number of patients assigned to each group over time would have been approximately equal. By this the unequal allocation of sample size, will be avoided. The concealed allocation of patient with HMT to the treatment groups will be explained by using SNOSE.

***(Figure 3.2)***

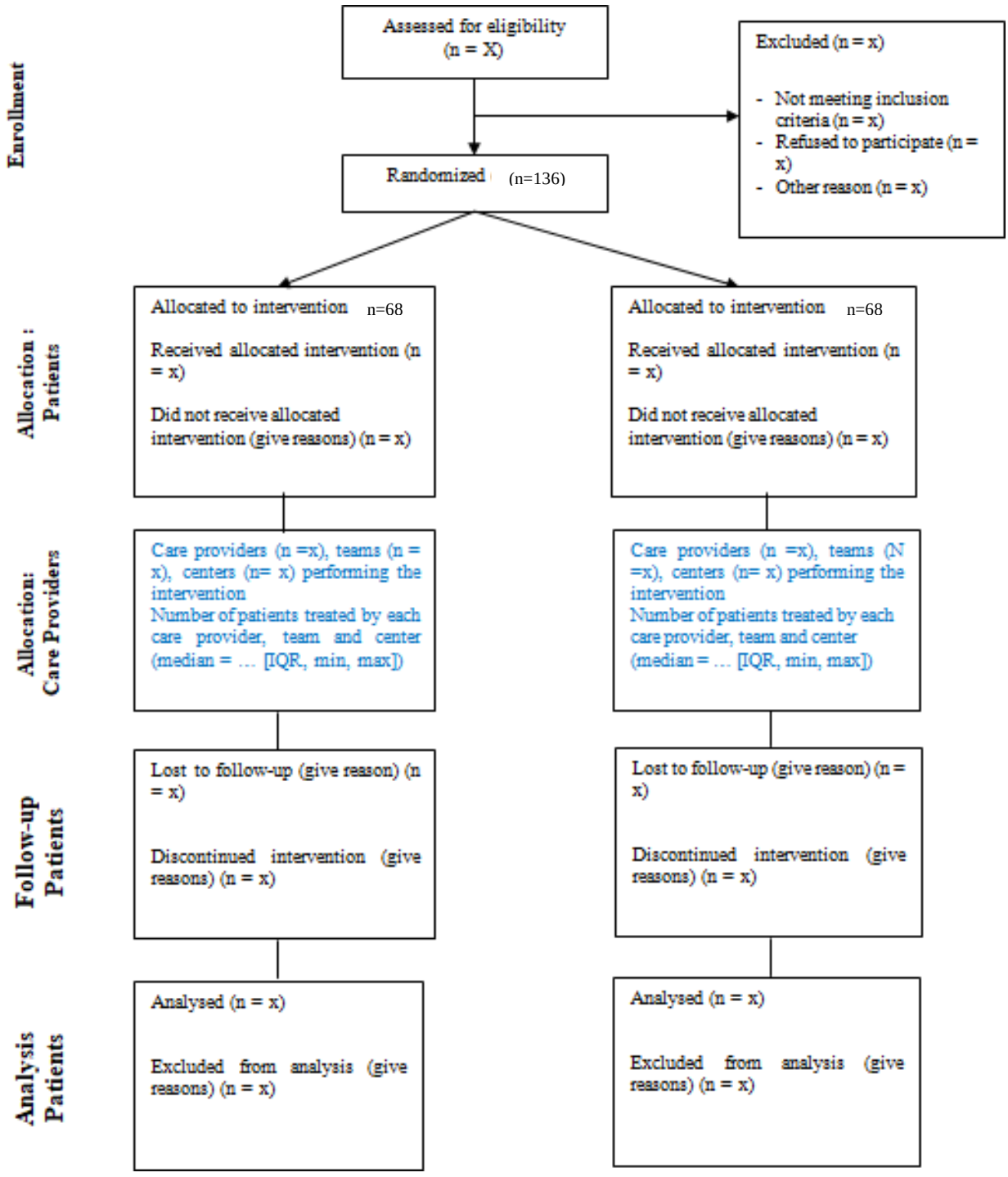
Enrollment
Assessed for eligibility (n = X)
Excluded (n = x)
- Not meeting inclusion criteria (n = x)
- Refused to participate (n = x)
- Other reason (n = x)
Randomized (n=136)
Allocation : Patients
Allocated to intervention n=68
Received allocated intervention (n = x)
Did not receive allocated intervention (give reasons) (n = x)
Allocated to intervention n=68
Received allocated intervention (n = x)
Did not receive allocated intervention (give reasons) (n = x)
Allocation: Care Providers
Care providers (n =x), teams (n = x), centers (n= x) performing the intervention
Number of patients treated by each care provider, team and center (median = … [IQR, min, max])
Care providers (n =x), teams (N =x), centers (n= x) performing the intervention
Number of patients treated by each care provider, team and center (median = … [IQR, min, max])
Follow-up Patients
Lost to follow-up (give reason) (n = x)
Discontinued intervention (give reasons) (n = x)
Lost to follow-up (give reason) (n = x)
Discontinued intervention (give reasons) (n = x)
Analysis Patients
Analysed (n = x)
Excluded from analysis (give reasons) (n = x)
Analysed (n = x)
Excluded from analysis (give reasons) (n = x)

**Figure 3.2: Study Flow Chart**

**Intervention details:**

All the interventions will be provided by the experienced and qualified physiotherapist. Participants in active HILT group will receive HILT intervention on the hamstring muscle. The dosage and parameters will be calculated,

**Irradiation parameters:**

Wavelength- 980 nm

Intensity/Power density- 3W/$cm^2$

Emission mode- Continuous Emission

Energy (Joules)- 630 J

Irradiation time- 70 Sec on each point

Peak power- 15 Watt

Irradiation points- 09

The laser will be used in a contact manner, with the beam spread over the belly of the hamstring muscle at nine places. The irradiation treatment spots (active or placebo) will be set at the midpoint of the total measurement obtained between ischial tuberosity to antero/postero-medial aspect of tibia and head of fibula bilaterally with 2cm between each point in order to standardise the laser application. Irradiation area will be on the hamstring muscle belly, 1/$3^{rd}$ part of total

muscle length. Laser will be applied in transverse area at three equal area of muscle belly with equal distance from mid point to lateral side. The total muscle length will be measured with the measuring tape and marked separately. ***(Figure 3.3)*** Participants and therapist will use eye protective glasses during the treatment procedure.

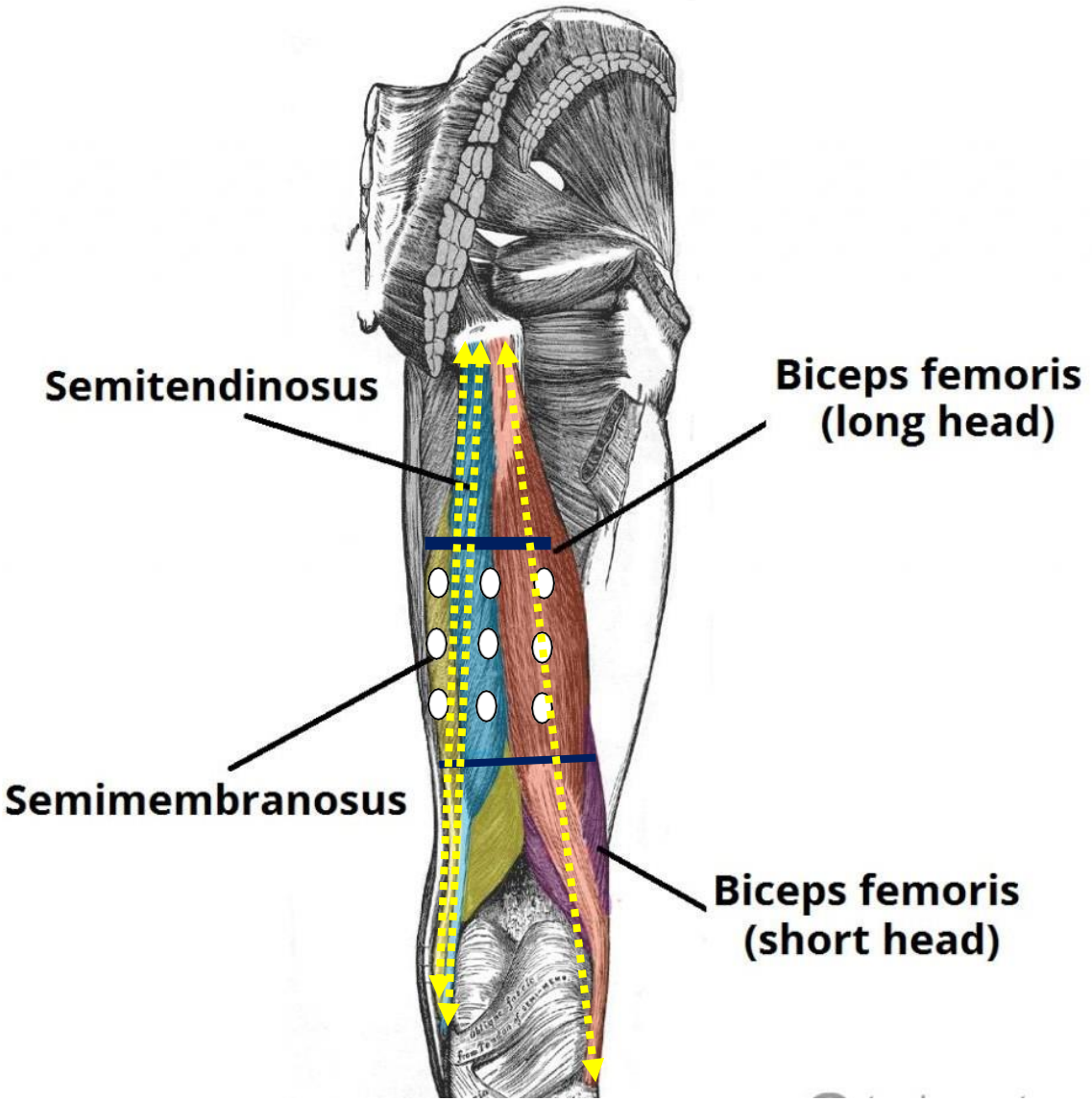


**Figure 3.3: Measurement of Irradiation Sites**

The participants will be in a side lying position with hip 80 degree in flexion and knee maximum extension. The laser probe will be placed on the all nine selected areas of the hamstring muscle longitudinally in contact method. Each session will be of 10 minutes in bilateral lower limb for 3 days/week up to 2 weeks.

**Outcome measures:**

The primary outcomes of this study are active knee extension test and sit and toe touch test to measure the tightness of the hamstring muscle. ***(Figure 3.4)***

| | | | STUDY PERIOD | | |
|---|---|---|---|---|---|
| | Enrolment | Allocation | Post-allocation (Treatment) | | Follow-up (Evaluation) |
| TIMEPOINT** | *0 week* | *1 week* | *1 week* | *2 week* | *2 week* |
| ENROLMENT: | | | | | |
| Eligibility screen | X | | | | |
| Informed consent | X | | | | |
| *Randomization* | X | | | | |
| Allocation | | X | | | |
| INTERVENTIONS: | | | | | |
| *Active HILT group interventions* | | | X | X | |
| *Placebo HILT group interventions* | | | X | X | |
| ASSESSMENTS: | | | | | |
| *Demographic data* | X | | | | |
| *Active Knee Extension Test* | X | | X | | X |
| *Sit and Reach Test* | X | | X | | X |

**Figure 3.4: Detailed Study Description**

**Active knee extension test**

Active knee extension test (AKET) is most reliable (test retest reliability 0.99) method to assess the hamstring tightness. Individual will be positioned supine lying on the examination table, non-measured extremity will be stabilized with the cloth strap to stabilize the pelvis and thigh. The examined extremity is maintained in hip flexion 80 degree and asked the participants to extend the knee at maximum extension.***(Figure 3.5)***

**Figure 3.5: Active Knee Extension Test**

**Sit and toe touch test**

Prior to the test, participants should stretch and warm up for a few minutes. The shoes of the participants should be taken off. On the floor, a yardstick will be set at a right angle to the 15-inch mark, and tape will be placed across it. The client/patient sits with the yardstick between their thighs and their legs stretched at right angles to the floor's taped line. The heels of the feet should be about 10 to 12 inches apart and touch the taped line's edge. Slowly reach forward with extended arms, one hand on top of the other, palms down, far as possible, and hold this position for 2 seconds. Make that the participant's hands are parallel and that he or she is not leading with only one hand. The measuring part or yardstick should be in touch with the fingertips, which can be overlapped. The score is determined by reaching the farthest point (in or cm) with the fingertips. Three trials should be documented, with the best being kept. Exhale and drop the head between the arms when reaching to help with the best try. The participant's knees should be stretched but not forced down by the testers. During the exam, the client/patient should breathe normally and not hold her/his breath at any point.***(Figure 3.6)*** Outcomes will be assessed two times first, at the baseline (before the intervention), and second post intervention (at the end of last session of 2 weeks).

**Figure 3.6: Sit and Toe Touch Test**

**Statistical analysis**

The collected demographic and outcome measures will be assessed for their normality using the Kolmogorov-Smirnov test. If the data follow the normal distribution, descriptive statistics will be expressed in mean ± standard deviation. A paired t-test will be adopted to determine the experimental and control groups' differences for pre-post intervention changes. In contrast, the independent t- test will be used to compare the changes in mean values of the outcome measures between the experimental and control groups at baseline and the end of 2 weeks of intervention. If the data does not follow a normal distribution, then the descriptive statistics will be reported in median with 95% confidence interval (CI) and range. Wilcoxon signed rank test will be adopted to find out the differences within experimental group and control group for pre-post intervention changes. While Mann Whitney U test will be used to compare the changes in mean values of the outcome measures between experimental group and control group at baseline and end of 2 weeks intervention. All the data will be analyzed using statistical software, statistical package for social science (SPSS), IBM SPSS version 20.0 (Armonk, NY: IBM Corp.). The p-value $\leq 0.05$ will be considered to be statistically significant.

## Chapter 4. Discussion

Lack of literature on effectiveness of high-intensity laser therapy on hamstring muscle tightness made us to think about this research. The objective is to find out the effectiveness of high-intensity laser therapy on hamstring muscle length among young adults. High-intensity laser therapy is known to boost metabolism and accelerate blood circulation through systemic vasodilation, resulting in the reabsorption of stored tissue material and the rapid elimination of exudates. In this study hamstring muscle length changes will be observed and recorded by measuring the changes in length with help of active knee extension test.

Homeostasis was influenced by high-intensity laser therapy, which increased ATP generation by producing thermal effects through photothermal interaction. High-intensity laser therapy loosens stiff tissue by increasing expansibility inside collagen tissue by stimulating cell metabolism, which is induced by increased local temperature. Previous studies on application of photobiomodulation in animal and human subjects have established significant effects in preventing muscle injury to be. However, available studies are only done on low level laser therapy but till date there is lack of evidence on high-intensity laser therapy. This study will help to establish an effective treatment protocol for normal adult population. The result of this study might be helpful The study entitled “High-intensity laser therapy on hamstring muscle length in

young adults" is aimed to under the effect of high-intensity laser therapy, young adult population may be able to increase their hamstring length.

**Strength of the study**

Dosage of high-intensity laser therapy will be calculated and established for thehamstring muscle tightness

Calculation of sample size prior to the study

**Limitations of the Study**

Other various factors including environmental modification, hormonal changes occurring within the subjects will not taken in to consideration.

Single centre study

Level of physical activity will not be taken into considerations

**Clinical significance:** In this study, participants will be benefited with high-intensity laser therapy as it improves individual's daily activities and prevent probabilities of muscle injury by improving the length of hamstring muscle. The probability of low back pain and muscle injury will be decreased and it result in improved living status and active life style.

**Further recommendation**

Study can be done in multi centre

Study can be done with larger population in different age groups

## Chapter 5: References


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# ANNEXURE 1

## Ethical Certificate

### INSTITUTIONAL ETHICAL COMMITTEE

**MAHARISHI MARKANDESHWAR INSTITUTE OF MEDICAL SCIENCES & RESEARCH MULLANA, AMBALA**

**Communication of Decision of the Ethics Committee (IEC)**

**Project No: IEC-** 2151

| |
|---|
| **Project Title**: High-intensity laser therapy on hamstring muscle length among young adults |
| Name of Student/Scholar: Adarsh Kumar Srivastav |
| Name of Institution: MMIPR, MULLANA (AMBALA) |
| ☑ New review ☐ Revised review ☐ Expedited review |
| Date of review (D/M/Y): 13-10-2021 |
| Date of previous review, if revised application: ---------- |
| Decision of the Ethics Committee: |
| ☑ Recommended ☐ Recommended with suggestions |
| ☐ Revision ☐ Rejected |
| Remarks: Approved |
| Recommended for a period of : 1 year |

**Please note ***

- **Inform EC immediately in case of any adverse events and serious adverse events.**
- **Inform EC in case of any change of study procedure, site and investigator**
- **This permission is only for period mentioned above. Annual report to be submitted to EC.**
- **Members of EC have right to monitor the trial with prior intimation.**

Signature of Member Secretary
Ethics Committee
MMIMSR

M.M. Institute of Medical & Research, Mullana (Ambala)

## ANNEXURE 2

**Consent Form (English)**

This informed consent form is for the individuals who are having tightness in the hamstring muscle and participating in this study.

**Name of Principal investigator:** Adarsh Kumar Srivastav, M.P.T.

**Name of organization:** Maharishi Markandeshwar Institute of Physiotherapy and Rehabilitation, Maharishi Markandeshwar (Deemed to be University), Mullana, Ambala, Haryana, India

**Name of Supervisor:** Dr. Asir John Samuel, Ph.D.

**Name of Proposal:** High-intensity laser therapy on hamstring muscle length among young adults

This informed consent is having two parts:

1. Information sheet
2. Certificate of consent

**Part 1: Information sheet**

**Introduction**

I am Mr. Adarsh Kumar Srivastav, Doctorate of Philosophy (Ph.D.) Scholar, in Maharishi Markandeshwar Institute of Physiotherapy and Rehabilitation, Maharishi Markandeshwar (Deemed to be University), Mullana, Ambala. We (Dr. Asir John Samuel [Supervisor], and

Adarsh Kumar Srivastav [Ph.D. Scholar]) are researching to establish effective treatment protocol for hamstring muscle tightness in healthy individual. I will give you all the detailed information about our research and invite you to participate in our research project. You can take your own time to think whether you will participate or not and you can talk to anyone you feel comfortable about the research.

**Purpose of the research**

To our knowledge no research has been done on the effectiveness of high-intensity laser therapy in improving hamstring flexibility in people who have tight hamstrings. However, there is no research had been conducted on high-intensity laser therapy to determine the proper parameters necessary to increase flexibility. The purpose of this research is to determine the effects of high-intensity laser therapy on hamstring muscle length (HML) in young adults. The research study will be conducted for the completion of a Ph.D. thesis work. If you have a question about this research, you can ask me or supporting staff associated with this study.

**Types of research intervention**

Hamstring tightness is one of the common problem among normal individuals because of our sedentary life style and many other factors. Ignorance of the hamstring muscle tightness could lead to the low back pain and may also affect the quality of life. To date, there is a lack of standard treatment protocol to deal with hamstring tightness. High intensity laser therapy might be helpful to reduce the tightness or improve the flexibility and affected quality of life in normal healthy individuals. Therefore, the purpose of the study is to establish the efficacy of high intensity laser therapy on hamstring muscle tightness among normal individuals.

**Participant's selection**

Before your participation, an investigator will take your brief medical history to determine your health status and problem, which would make you eligible to participate. You will be asked to provide general information about yourself age and a few general parameters will also be recorded. You will be assigned a subject number so that your name will not be associated with any of the findings of the study.

**Voluntary participation**

Your participation in this research is voluntary. It is your choice whether to participate or not. If you do not want to participate in this research, you will be offered treatment that is routinely given for hamstring muscle tightness. You have the right to withdraw from the study at any time.

**Information on the trial**

The intervention we are using in this trial is high intensity laser therapy. It has been used before to treat the other conditions for relieving the pain and increase extensibility of tissues in different populations. We want to test the efficacy of high intensity laser therapy intervention on normal younger adults to improve the hamstring muscle flexibility.

**Procedures and Protocol**

We will divide all participants into two groups randomly. One group will receive Active high intensity laser therapy and another group will receive placebo high intensity laser therapy. We will record the outcome at baseline, end of the 2-week post-intervention period by using active knee extension test and sit and toe touch test.

**A. Unfamiliar Procedures**

We need to find the effect of high intensity laser therapy intervention since we do not know if the active high intensity laser therapy is better than the sham high intensity laser therapy for treating hamstring muscle tightness. To accomplish so, we'll divide the participants in this study into two groups. The groupings are chosen at random, as though by a computer generated randomization. Those in one group will receive the active high intensity laser therapy, while participants in the other group will receive the sham high intensity laser therapy. It is critical that neither you nor we know which of the two interventions you will be given. This information will be saved in our files, but we will not examine them until the research is completed. Then we will see which of the two produces the best outcomes. During the study, the healthcare workers will closely monitor you and the other participants. If we are concerned about the intervention effects, we will determine which method of intervention you are receiving and make appropriate changes. If you have any concerns or questions about the research, please contact me or one of the other researchers.)

**B. Description of the Process**

We will include the participants affected with hamstring muscle tightness and confirmed by active knee extension test. After the recruitment we will randomize all the participants in the two group (active HILT and sham HILT). The experienced and qualified physiotherapist will provide all the interventions. Participants in active HILT group will receive HILT intervention on the hamstring muscle. Each session will be of 10 minutes in bilateral lower limb for 3 days/week up to 2 weeks.

**Duration**

At the first visit, we will record your hamstring tightness followed by treatment (high intensity laser therapy) for 3 days a week. The treatment protocol will continue for 2 weeks after that we will record your muscle tightness level again to see the pre-test and post-test improvement.

**Side effects**

There will be no side effects of our intervention. To assure the safety of the participant, loud and clear instructions will be administered. One staff will stand near the subject for ensuring safety.

**Risks**

The risk of participation in this study is minimal.

**Discomforts**

By participating in this research it is possible that you might experience some discomfort such as warmth sensation during laser therapy application. This should be normal after the treatment session, but if you are concerned, please contact to us.

**Benefits**

You will receive the following benefits if you participate in this study: any intermediate condition will be treated at no cost to you. It is non-invasive and painless method to improve the muscle length. Available treatment techniques are painful; or time consuming. Although there may be no direct advantage to you, your involvement is likely to assist us in determining the answer to the study question. At this point in the research, there may be little value to society, but future generations are likely to profit.

**Reimbursements**

We will not charge for any diagnostic or treatment cost. Furthermore, we cannot be able to pay you for your travelling and participation because the study is not funded for this purpose.

**Confidentiality**

The information that we collect from this research will be kept confidential. Information about you that will be collected during the research will be put away and no-one but the researchers will be able to see it. Any information about you will have a number on it instead of your name. Only the researchers will know what your number is and we will lock that information up with a lock and key. It will not be shared with or given to anyone.

**Sharing the result**

The knowledge that we get from doing this research will be shared with you through community meetings before it is made widely available to the public. Confidential information will not be shared. There will be small meetings in the community and these will be announced. After these meetings, we will publish the results so that other interested people may learn from our research.

**Right to Refuse or Withdraw**

You are not obligated to participate in this study if you do not choose to. You can also choose to discontinue participating in the study at any time. It is your decision, and all of your rights will be maintained.

**Alternatives to Participating**

If you do not want to participate in the study, you will be treated according to the hospital's standard of care. Individuals who have hamstring muscle tightness are given stretching exercises or thermal/non thermal modality.

**Who to Contact**

If you have any questions you may ask them any time before or during the study period. If you want to ask any questions later, you may contact any of the following:

1. **Name:** Mr. Adarsh Kumar Srivastav

**Address:** Maharishi Markandeshwar Institute of Physiotherapy and Rehabilitation, Maharishi Markandeshwar (Deemed to be University), Mullana, Ambala

**Telephone number:** +918618889003

**E-mail:** adarshsrivastava13@gmail.com

2. **Name:** Dr. Asir John Samuel

**Address:** Maharishi Markandeshwar Institute of Physiotherapy and Rehabilitation, Maharishi Markandeshwar (Deemed to be University), Mullana, Ambala

**Telephone number:** +918059930222

**E-mail:** asirjohnsamuel@mmumullana.org

## Part 2: Certificate of Consent

I have read the foregoing information, or it has been read to me. I have had the opportunity to ask questions about it and any questions that I have asked have been answered to my satisfaction. I consent voluntarily to participate as a participant in this research.

Print Name of Participant_____

Signature of Participant _____

Date _____

Day/month/year

If illiterate

A literate witness should sign (if possible, this person should be selected by the participant, there should be no connection to the parent and research team). For those who are illiterate, their thumbprint should also be included.

Print name of witness_____ AND Thumb print of participant

Signature of witness _____

Date_____(Day/month/year)

**Statement by the researcher/person taking consent**

I have accurately read out the information sheet to the potential participant, and to the best of my ability made sure that the participant understands that the following will be done:

1.

2.

3.

I confirm that the participant was allowed to ask questions about the study, and all the questions asked by the participant have been answered correctly and to the best of my ability. I confirm that the individual has not been forced into giving consent, and the consent has been given freely and voluntarily.

A copy of this ICF has been provided to the participant.

Print Name of Researcher/person taking the consent_____

Signature of Researcher /person taking the consent_____

Date _____

Day/month/year

**ANNEXURE 3**

# सूचित सहमति फॉर्म

## सहमति प्रपत्र (हिंदी)

यह सूचित सहमति प्रपत्र उन व्यक्तियों के लिए है जिनकी हैमस्ट्रिंग मांसपेशियों में जकड़न है और जो इस अध्ययन में भाग ले रहे हैं।

**प्रधान अन्वेषक का नाम:** आदर्श कुमार श्रीवास्तव, एम.पी.टी.

**संगठन का नाम:** महर्षि मार्कंडेश्वर इंस्टीट्यूट ऑफ फिजियोथेरेपी एंड रिहैबिलिटेशन, महर्षि मार्कंडेश्वर (डीम्ड टू बी यूनिवर्सिटी), मुलाना, अंबाला, हरियाणा, भारत

**पर्यवेक्षक का नाम:** डॉ. आसिर जॉन सैमुअल, पीएच.डी.

**प्रस्ताव का नाम:** युवा वयस्कों में हैमस्ट्रिंग मांसपेशियों की लंबाई पर उच्च-तीव्रता वाली लेजर थेरेपी

इस सूचित सहमति के दो भाग हैं:

1. सूचना पत्र
2. सहमति का प्रमाण पत्र

### भाग 1: सूचना पत्र

## परिचय

मैं आदर्श कुमार श्रीवास्तव, डॉक्टरेट ऑफ फिलॉसफी (पीएचडी) स्कॉलर, महर्षि मार्कंडेश्वर इंस्टीट्यूट ऑफ फिजियोथेरेपी एंड रिहैबिलिटेशन, महर्षि मार्कंडेश्वर (डीम्ड टू बी यूनिवर्सिटी), मुलाना, अंबाला में हूं। हम (डॉ. आसिर जॉन सैमुअल [पर्यवेक्षक], और आदर्श कुमार श्रीवास्तव [पीएचडी स्कॉलर]) स्वस्थ व्यक्ति में हैमस्ट्रिंग मांसपेशियों की जकड़न के लिए प्रभावी उपचार प्रोटोकॉल स्थापित करने के लिए शोध कर रहे हैं। मैं आपको हमारे शोध के बारे में सभी विस्तृत जानकारी दूंगा और आपको हमारी शोध परियोजना में भाग लेने के लिए आमंत्रित करूंगा। आप यह सोचने के लिए अपना समय ले सकते हैं कि आप भाग लेंगे या नहीं और आप किसी से भी बात कर सकते हैं जिसे आप शोध के बारे में सहज महसूस करते हैं।

## शोध का उद्देश्य

हमारे ज्ञान के लिए, तंग हैमस्ट्रिंग वाले लोगों में हैमस्ट्रिंग लचीलेपन में सुधार के लिए उच्च-तीव्रता वाले लेजर थेरेपी की प्रभावशीलता पर कोई शोध नहीं किया गया है। हालांकि, लचीलेपन को बढ़ाने के लिए आवश्यक उचित मापदंडों को निर्धारित करने के लिए उच्च-तीव्रता वाली लेजर थेरेपी पर कोई शोध नहीं किया गया है। इस शोध का उद्देश्य युवा वयस्कों में हैमस्ट्रिंग मांसपेशियों की लंबाई (एचएमएल) पर उच्च-तीव्रता वाली लेजर थेरेपी के प्रभावों को निर्धारित करना है। शोध अध्ययन एक पीएच.डी. पूरा करने के लिए आयोजित किया जाएगा। थीसिस कार्य। यदि इस शोध के बारे में आपका कोई प्रश्न है, तो आप मुझसे या इस अध्ययन से जुड़े सहयोगी स्टाफ से पूछ सकते हैं।

## अनुसंधान हस्तक्षेप के प्रकार

हमारी गतिहीन जीवन शैली और कई अन्य कारकों के कारण सामान्य व्यक्तियों में हैमस्ट्रिंग जकड़न एक आम समस्या है। हैमस्ट्रिंग मांसपेशियों की जकड़न की अनदेखी से पीठ के निचले हिस्से में दर्द हो सकता है और यह जीवन की गुणवत्ता को भी प्रभावित कर सकता है। आज तक, हैमस्ट्रिंग की जकड़न से निपटने के लिए मानक उपचार प्रोटोकॉल का अभाव है। उच्च तीव्रता वाली लेजर थेरेपी सामान्य स्वस्थ व्यक्तियों में जकड़न को कम करने या लचीलेपन और जीवन की प्रभावित गुणवत्ता में सुधार करने में सहायक हो सकती है। इसलिए, अध्ययन का उद्देश्य सामान्य व्यक्तियों

में हैमस्ट्रिंग मांसपेशियों की जकड़न पर उच्च तीव्रता वाली लेजर थेरेपी की प्रभावकारिता स्थापित करना है।

**प्रतिभागी का चयन**

आपकी भागीदारी से पहले, एक अन्वेषक आपकी स्वास्थ्य स्थिति और समस्या का निर्धारण करने के लिए आपका संक्षिप्त चिकित्सा इतिहास लेगा, जो आपको भाग लेने के योग्य बनाएगा। आपको अपनी उम्र के बारे में सामान्य जानकारी प्रदान करने के लिए कहा जाएगा और कुछ सामान्य पैरामीटर भी दर्ज किए जाएंगे। आपको एक विषय संख्या दी जाएगी ताकि आपका नाम अध्ययन के किसी भी निष्कर्ष के साथ संबद्ध न हो।

**स्वैच्छिक भागीदारी**

इस शोध में आपकी भागीदारी स्वैच्छिक है। यह आपकी मर्जी है कि भाग लेना है या नहीं। यदि आप इस शोध में भाग नहीं लेना चाहते हैं, तो आपको ऐसे उपचार की पेशकश की जाएगी जो नियमित रूप से हैमस्ट्रिंग मांसपेशियों की जकड़न के लिए दिया जाता है। आपको किसी भी समय अध्ययन से हटने का अधिकार है।

**प्रक्रिया की जानकारी**

इस परीक्षण में हम जिस हस्तक्षेप का उपयोग कर रहे हैं वह उच्च तीव्रता वाली लेजर थेरेपी है। दर्द से राहत और विभिन्न आबादी में ऊतकों की विस्तारशीलता बढ़ाने के लिए अन्य स्थितियों के इलाज के लिए इसका उपयोग पहले किया गया है। हम हैमस्ट्रिंग मांसपेशियों के लचीलेपन में सुधार के लिए सामान्य युवा वयस्कों पर उच्च तीव्रता वाले लेजर थेरेपी हस्तक्षेप की प्रभावकारिता का परीक्षण करना चाहते हैं।

**प्रक्रियाएं और प्रोटोकॉल**

हम सभी प्रतिभागियों को यादृच्छिक रूप से दो समूहों में विभाजित करेंगे। एक समूह सक्रिय उच्च तीव्रता लेजर थेरेपी प्राप्त करेगा और दूसरा समूह नकली उच्च तीव्रता लेजर थेरेपी प्राप्त करेगा। हम सक्रिय घुटने के विस्तार परीक्षण और बैठने और पैर की अंगुली स्पर्श परीक्षण का उपयोग करके बेसलाइन पर 2 सप्ताह के बाद की अवधि के अंत में परिणाम रिकॉर्ड करेंगे।

**अपरिचित प्रक्रियाएं**

हमें उच्च तीव्रता वाले लेजर थेरेपी हस्तक्षेप के प्रभाव को खोजने की आवश्यकता है क्योंकि हम नहीं जानते हैं कि सक्रिय उच्च तीव्रता लेजर थेरेपी हैमस्ट्रिंग मांसपेशियों की जकड़न के इलाज के लिए नकली उच्च तीव्रता लेजर थेरेपी से बेहतर है या नहीं। ऐसा करने के लिए, हम इस अध्ययन के प्रतिभागियों को दो समूहों में विभाजित करेंगे। समूहों को यादृच्छिक रूप से चुना जाता है, जैसे कि कंप्यूटर द्वारा उत्पन्न यादृच्छिकरण। एक समूह के लोग सक्रिय उच्च तीव्रता वाली लेजर थेरेपी प्राप्त करेंगे, जबकि दूसरे समूह के प्रतिभागियों को नकली उच्च तीव्रता वाली लेजर थेरेपी प्राप्त होगी। यह महत्वपूर्ण है कि न तो आप और न ही हम जानते हैं कि आपको दोनों में से कौन सा हस्तक्षेप दिया जाएगा। यह जानकारी हमारी फाइलों में सहेजी जाएगी, लेकिन शोध पूरा होने तक हम उनकी जांच नहीं करेंगे। फिर हम देखेंगे कि दोनों में से कौन सबसे अच्छा परिणाम देता है। अध्ययन के दौरान, स्वास्थ्य कर्मी आपकी और अन्य प्रतिभागियों की बारीकी से निगरानी करेंगे। यदि हम हस्तक्षेप के प्रभावों के बारे में चिंतित हैं, तो हम यह निर्धारित करेंगे कि आपको हस्तक्षेप का कौन सा तरीका प्राप्त हो रहा है और उचित परिवर्तन करेंगे। यदि आपको शोध के बारे में कोई चिंता या प्रश्न हैं, तो कृपया मुझसे या अन्य शोधकर्ताओं में से किसी एक से संपर्क करें।)

**प्रक्रिया का विवरण**

हम हैमस्ट्रिंग मांसपेशियों की जकड़न से प्रभावित और सक्रिय घुटने के विस्तार परीक्षण द्वारा पुष्टि किए गए प्रतिभागियों को शामिल करेंगे। भर्ती के बाद हम सभी प्रतिभागियों को दो समूहों (सक्रिय एचआईएलटी और नकली एचआईएलटी) में यादृच्छिक करेंगे। अनुभवी और योग्य फिजियोथेरेपिस्ट सभी हस्तक्षेप प्रदान करेंगे। सक्रिय एचआईएलटी समूह के प्रतिभागियों को हैमस्ट्रिंग पेशी पर एचआईएलटी हस्तक्षेप प्राप्त होगा। प्रत्येक सत्र द्विपक्षीय निचले अंगों में ३ दिन/सप्ताह में २ सप्ताह तक १० मिनट का होगा।

**अवधि**

पहली मुलाकात में, हम आपकी हैमस्ट्रिंग जकड़न को रिकॉर्ड करेंगे और उसके बाद सप्ताह में 3 दिन उपचार (उच्च तीव्रता वाली लेजर थेरेपी) करेंगे। उपचार प्रोटोकॉल 2 सप्ताह तक जारी रहेगा उसके बाद हम पूर्व-परीक्षण और परीक्षण के बाद सुधार देखने के लिए आपकी मांसपेशियों की जकड़न के स्तर को फिर से रिकॉर्ड करेंगे।

**दुष्प्रभाव**

हमारे हस्तक्षेप का कोई दुष्प्रभाव नहीं होगा। प्रतिभागी की सुरक्षा सुनिश्चित करने के लिए, ज़ोर से और स्पष्ट निर्देश दिए जाएंगे। सुरक्षा सुनिश्चित करने के लिए एक कर्मचारी विषय के पास खड़ा होगा।

**जोखिम**

इस अध्ययन में भाग लेने का जोखिम न्यूनतम है।

**असुविधाएँ**

इस शोध में भाग लेने से यह संभव है कि आप कुछ असुविधा का अनुभव कर सकते हैं जैसे कि लेजर थेरेपी के प्रयोग के दौरान गर्मी का अहसास। उपचार सत्र के बाद यह सामान्य होना चाहिए, लेकिन यदि आप चिंतित हैं, तो कृपया हमसे संपर्क करें।

**लाभ**

यदि आप इस अध्ययन में भाग लेते हैं तो आपको निम्नलिखित लाभ प्राप्त होंगे: किसी भी मध्यवर्ती स्थिति का इलाज आपके लिए किसी भी कीमत पर नहीं किया जाएगा। यह मांसपेशियों की लंबाई में सुधार करने के लिए गैर-आक्रामक और दर्द रहित तरीका है। उपलब्ध उपचार तकनीक दर्दनाक हैं; या समय लेने वाला। यद्यपि आपको कोई प्रत्यक्ष लाभ नहीं हो सकता है, आपकी भागीदारी से अध्ययन प्रश्न का उत्तर निर्धारित करने में हमारी सहायता करने की संभावना है। अनुसंधान में इस बिंदु पर, समाज के लिए बहुत कम मूल्य हो सकता है, लेकिन आने वाली पीढ़ियों को लाभ होने की संभावना है।

**पैसे की वापसी**

हम किसी भी निदान या उपचार लागत के लिए शुल्क नहीं लेंगे। इसके अलावा, हम आपकी यात्रा और भागीदारी के लिए आपको भुगतान करने में सक्षम नहीं हैं क्योंकि अध्ययन इस उद्देश्य के लिए वित्त पोषित नहीं है।

**गोपनीयता**

इस शोध से जो जानकारी हम एकत्र करते हैं उसे गोपनीय रखा जाएगा। आपके बारे में जो जानकारी शोध के दौरान

एकत्र की जाएगी उसे हटा दिया जाएगा और इसे कोई और नहीं बल्कि शोधकर्ता देख पाएंगे। आपके बारे में किसी भी जानकारी पर आपके नाम की जगह एक नंबर होगा। केवल शोधकर्ताओं को ही पता चलेगा कि आपका नंबर क्या है और हम उस जानकारी को एक ताला और चाबी से बंद कर देंगे। इसे किसी के साथ साझा या दिया नहीं जाएगा।

**परिणाम साझा करना**

इस शोध को करने से हमें जो ज्ञान प्राप्त होता है, उसे जनता के लिए व्यापक रूप से उपलब्ध कराने से पहले सामुदायिक बैठकों के माध्यम से आपके साथ साझा किया जाएगा। गोपनीय जानकारी साझा नहीं की जाएगी। समुदाय में छोटी-छोटी बैठकें होंगी और इनकी घोषणा की जाएगी। इन बैठकों के बाद, हम परिणाम प्रकाशित करेंगे ताकि अन्य इच्छुक लोग हमारे शोध से सीख सकें।

**मना करने या वापस लेने का अधिकार**

यदि आप नहीं चुनते हैं तो आप इस अध्ययन में भाग लेने के लिए बाध्य नहीं हैं। आप किसी भी समय अध्ययन में भाग लेना बंद करना भी चुन सकते हैं। यह आपका निर्णय है, और आपके सभी अधिकार बनाए रखे जाएंगे।

**भाग लेने के विकल्प**

यदि आप अध्ययन में भाग नहीं लेना चाहते हैं, तो आपका इलाज अस्पताल के देखभाल के मानक के अनुसार किया जाएगा। मांसपेशियों में जकड़न वाले व्यक्तियों को स्ट्रेचिंग व्यायाम या थर्मल / नॉन थर्मल मोडेलिटी दी जाती है।

**किससे संपर्क करें**

यदि आपके कोई प्रश्न हैं, तो आप उनसे अध्ययन अवधि से पहले या उसके दौरान किसी भी समय पूछ सकते हैं। यदि आप बाद में कोई प्रश्न पूछना चाहते हैं, तो आप निम्न में से किसी से भी संपर्क कर सकते हैं:

1. नाम: आदर्श कुमार श्रीवास्तव

पता: महर्षि मार्कंडेश्वर इंस्टीट्यूट ऑफ फिजियोथेरेपी एंड रिहैबिलिटेशन, महर्षि मार्कंडेश्वर (डीम्ड टू बी यूनिवर्सिटी), मुलाना, अंबाला

टेलीफोन नंबर: +918618889003

ई-मेल: adarshsrivastava13@gmail.com

2. नाम: डॉ आसिर जॉन सैमुअल

पता: महर्षि मार्कंडेश्वर इंस्टीट्यूट ऑफ फिजियोथेरेपी एंड रिहैबिलिटेशन, महर्षि मार्कंडेश्वर (डीम्ड टू बी यूनिवर्सिटी), मुलाना, अंबाला

टेलीफोन नंबर: +918059930222

ई-मेल: asirjohnsamuel@mmumullana.org

## भाग 2: सहमति का प्रमाण पत्र

मैंने पूर्वगामी जानकारी पढ़ ली है, या यह मुझे पढ़ ली गई है। मुझे इसके बारे में प्रश्न पूछने का अवसर मिला है और मेरे द्वारा पूछे गए किसी भी प्रश्न का उत्तर मेरी संतुष्टि के अनुरूप दिया गया है। मैं स्वेच्छा से इस शोध में भागीदार के रूप में भाग लेने के लिए सहमत हूं।

प्रतिभागी का प्रिंट नाम_____

प्रतिभागी के हस्ताक्षर _____

दिनांक _____

दिन महीने साल

अगर अनपढ़

एक साक्षर गवाह को हस्ताक्षर करना चाहिए (यदि संभव हो तो, इस व्यक्ति को प्रतिभागी द्वारा चुना जाना चाहिए,

माता-पिता और शोध दल से कोई संबंध नहीं होना चाहिए)। जो अनपढ़ हैं, उनके अंगूठे का निशान भी शामिल किया जाना चाहिए।

गवाह का नाम _____ और प्रतिभागी का अंगूठा प्रिंट

गवाह के हस्ताक्षर _____

दिनांक _____ (दिन/माह/वर्ष)

शोधकर्ता/सहमति लेने वाले व्यक्ति का कथन

मैंने संभावित प्रतिभागी को सूचना पत्रक को सही ढंग से पढ़ा है, और अपनी सर्वोत्तम क्षमता से यह सुनिश्चित किया है कि प्रतिभागी समझता है कि निम्नलिखित किया जाएगा:

1.

2.

3.

मैं पुष्टि करता हूं कि प्रतिभागी को अध्ययन के बारे में प्रश्न पूछने की अनुमति दी गई थी, और प्रतिभागी द्वारा पूछे गए सभी प्रश्नों का उत्तर मेरी क्षमता के अनुसार सही और सही दिया गया है। मैं पुष्टि करता हूं कि व्यक्ति को सहमति देने के लिए मजबूर नहीं किया गया है, और सहमति स्वतंत्र रूप से और स्वेच्छा से दी गई है।

इस आईसीएफ की एक प्रति प्रतिभागी को प्रदान की गई है।

सहमति लेने वाले अनुसंधानकर्ता/व्यक्ति का नाम _____

सहमति लेने वाले अनुसंधानकर्ता/व्यक्ति के हस्ताक्षर_____

दिनांक _____दिन महीने साल

## ANNEXURE 4

## Data collection form

**Name:-**

**Age (Years):-**

**Gender:-**

**Date of assessment:-**

| **Code:-** | | |
|---|---|---|
| **Outcome Measure** | **Pre-test** | **Post-test** |
| **Active Knee Extension Test (in Degree)** | | |
| **Sit and Toe Touch Test (in Centimeter)** | | |

## ANNEXURE 5

## Plagiarism Report

URKUND

# Urkund Analysis Result

| | |
|---|---|
| Analysed Document: | AKS_Synopsis.docx (D111662558) |
| Submitted: | 8/25/2021 11:37:00 AM |
| Submitted By: | asirjohnsamuel@mmumullana.org |
| Significance: | 4 % |

Sources included in the report:

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